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ABSTRACT

Children ages 30 to 34 months, assessed at 18 months for security of attachment and categorized as anxious/avoidant, anxious/resistant, or securely attached, were observed exploring with their mothers in a large-scale laboratory space. (Quality of attachment was assessed by means of Ainsworth's standard strange-situation procedure.) After learning a specific route through the laboratory space to a goal, the children were required to invent new routes to the goal. Quantity of exploration was measured by number of movements, and mode of exploration was measured by the extent of active versus passive movements. Among the results, children who had been classified as securely attached explored more independently and had less restricted patterns of exploration than did anxiously attached children. Securely attached children also scored higher on tasks of spatial ability. Findings suggest that individual differences in security of attachment, mode of exploration, and cognitive mapping abilities exert mutual effects upon each other throughout children's early development. (Author/DB)

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The Relationship of Security of Attachment to Exploration and Cognitive Mapping Abilities in Two-Year-Olds

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Running head: Attachment, Exploration, and Cognitive Mapping

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Abstract

Children aged 30-34 months who had been assessed at 18 months for security of attachment were observed exploring with their mothers in a large-scale laboratory space and were then given tasks to assess their knowledge of that space. After learning a specific route through the space to a goal, they were required to invent new routes to the goal. Results indicated that children who had been classified as securely attached explored relatively more independently and had less restricted patterns of exploration than did anxiously attached children. They also scored higher on tasks of spatial ability. It was proposed that individual differences in security of attachment, mode of exploration, and cognitive mapping abilities exert mutual effects upon each other throughout early development. This research contributes to a growing body of studies that indicate that security of attachment affects later competence in environmental adaptation.

The Relationship of Security of Attachment to Exploration and Cognitive Mapping Abilities in Two-Year-Olds

In cognitive mapping, as in many other endeavors, some children are better than others. Some travel effortlessly from place to place, remaining oriented even in relatively unfamiliar environments, while others seem to get hopelessly lost whenever their parents' backs are turned. The purpose of this research is to investigate factors that may underlie these individual differences.

One such factor may be the mode in which the child characteristically experiences the environment. Mode of experience, as defined by Acredolo (Note 1), refers to the active-versus-passive dimension of experience, such that self-generated exploration is viewed as the active mode while other-generated exploration is viewed as the passive mode. Feldman and Acredolo (1979) found that preschool children who walked by themselves to a location remembered the location better than children who were led to the location by an adult. Similar findings have recently been reported by Benson and Uzgiris (Note 2) for ten-month-old infants. These findings suggest that if mode of exploration is stable within individuals across situations, it may be a particularly critical factor in the developing cognitive mapping abilities of very young children.

In a study of children from 20 months to 3 years of age, Hazen (Note 3) did in fact find evidence of stable individual differences in mode of exploration, and these were related to cognitive mapping abilities. Children who explored relatively actively were better able to reverse a route and to infer alternate routes to a goal than children who explored relatively passively. In fact, cognitive mapping performance was much more strongly related to

children's mode of exploration than to their amount of exploration.

If individual differences in mode of exploration seem to be related to cognitive mapping abilities, it becomes important to identify children who might be predisposed to explore in one mode versus another. The mother-child relationship would seem to be an important determinant of the extent to which the child explores independently. In fact, in Bowlby's ethological theory of attachment, individual differences in security of attachment are defined to a large extent by the balance infants show between exploring and seeking proximity to their mothers. Thus, it may be that individual differences in security of attachment in infancy may affect mode of exploration, and perhaps as a result, cognitive mapping abilities, during the third year of life.

Security of attachment has generally been assessed using Ainsworth's strange situation procedure (Ainsworth and Wittig, 1976), which is based on Bowlby's ethological theory, and has been extensively validated (see Ainsworth et. al., 1978; Sroufe & Waters, 1977, for reviews). In this procedure, the infant is involved in two separations and reunions with the mother in an unfamiliar laboratory environment. Attachment classifications are determined by observing the infant's behavior throughout the procedure, but especially during the reunion episodes. Infants are classified into three main groups: securely attached (Group B), anxious/avoidant (Group A), and anxious/resistant (Group C). Securely attached infants use the mother as a secure base for exploration before separation, are less exploratory when the mother is replaced by a stranger, actively greet or seek contact with the mother during reunion, and are able to return to active exploration after reunion. Anxious/avoidant infants tend to explore without interaction before separation, behave similarly toward the mother and the stranger, and avoid the

mother while continuing to explore during reunion. Anxious/resistant infants show limited exploratory behavior even in the mother's presence, become extremely distressed by separation, and often mix proximity seeking with resistance and anger during reunion. The three main groups can be further divided into eight specific subgroups. (For complete descriptions of the behavior patterns characteristic of the eight subgroups as well as the three main groups, see Ainsworth et. al., 1978). Thus, in the strange situation, the anxious/avoidant Group A is highest in independent exploration, while the anxious/resistant Group C is lowest. The securely attached infants, Group B, balance exploration with proximity seeking and are intermediate between Groups A and C in exploration.

Two conflicting hypotheses concerning the effect of security of attachment on later exploration and spatial cognition can be generated. One hypothesis is that exploratory behavior will remain stable over time, and that therefore Group A will continue to be the most active explorers. Also, because of their greater environmental experience, A's will be highest in cognitive mapping ability. Group B would be second highest in both of these, and Group C lowest. A second hypothesis is that continuity will not be found in the stability of exploratory behavior per se, but rather in general styles of child-environment interation. In this case, children showing most competent adaptation to the environment at age one balance exploration with seeking proximity to their mothers, while competent children at age two seek autonomy and independent mastery of the environment. Thus, Group B would be expected to surpass Group A in active exploration, and to be highest in spatial cognitive abilities as well.

Based on both theoretical and empirical considerations, it was predicted that the second hypothesis would be confirmed. Sroufe (1979) has argued that

continuity in individual development must be found by "seeking qualitative similarities in patterns of development over time, rather than behavioral identities" (p. 834). Developmental change is accompanied by dramatic changes in behavioral repertoire, so continuities in specific behaviors over time should not be expected. Instead, continuity can be expected in quality of individual adaptation to developmentally appropriate tasks. Studies have demonstrated that toddlers who were assessed as securely attached tend to be more persistent, enthusiastic, and effective in problem solving (Matas, Arend, & Sroufe, 1978), and are more sociable with peers (Pastor, 1981). As preschoolers, securely attached children show greater flexibility and resourcefulness (Arend, Gove, & Sroufe, 1979), and greater peer competence (Waters, Wippman & Sroufe, 1979). Thus, it was predicted that securely attached children would by the age of 2½ be more independent in exploration and more competent in cognitive mapping abilities than children in the two insecurely attached groups.

METHOD

Subjects

The sample consisted of white, middle-class children who had participated in an earlier study of attachment at the age of 12 months. As part of that study, they were brought by their mothers to a university laboratory and assessed for quality of attachment in Ainsworth's standard strange-situation procedure. (See Ainsworth et. al., 1978, for a detailed description of this procedure). Of the 39 subjects who participated in that study, 30 were still living in the Austin area, and 28 of their mothers agreed to participate in the present study. The 14 males and 14 females who participated ranged in age from 30 to 34 months (mean age = 32 months). Four of these children had

been classified as anxious/avoidant (Ainsworth's Group A), 4 as anxious/resistant (Ainsworth's Group C), and 20 as securely attached (Ainsworth's Group B). According to Ainsworth et. al. (1978), children in subgroup B1 are similar to those in Group A in the balance they show between exploration and proximity seeking in the strange situation, while children in subgroup B4 are similar to those in Group C in this respect. Accordingly, children who fell into the borderline subgroups of Group B were regrouped into Groups A and C. After regrouping, 8 children were classified as anxious/avoidant, 7 as anxious/resistant, and 13 as securely attached.

Apparatus

Assessments of both exploration and spatial cognition were conducted in a large laboratory room (11.3 m. x 7.0 m.) containing a "playhouse" which consisted of four collapsible rooms (each 168 cm. x 168 cm. x 183 cm.) arranged as shown in figure 1. Each room had a 54 cm. wide opaque curtain door located in the center of each wall. The rooms were uniform except that each had a different colored circle of contact paper placed on the center of the floor so that children could distinguish them without receiving directional cues. A translucent ceiling was draped over the rooms to eliminate overhead directional cues.

Assessment of Exploration

Procedure. Exploration and cognitive mapping abilities were assessed by an experimenter and an assistant experimenter who were unaware of the children's attachment classifications. The experimenter, the mother, and the child first participated in a ten minute play session to help the child feel comfortable with the experimenter. The experimenter then brought the mother and child

to the playhouse and told them that they were free to explore it. Mothers had previously been told that the purpose of this part of the study was to observe how their children explored unfamiliar environments, and that they should behave as they normally would in such a situation.

The child's exploration was then observed by the experimenter and her assistant. The large laboratory room contained 12 areas that could be explored: the interiors of the 4 playhouse rooms, and 8 arbitrarily designated areas outside the playhouse. Each time the child moved to a different area, the observers recorded which area it was, and the mode used to reach it. If a child moved alone or led the mother, the movement was classified as active. If a child followed the mother, was led or carried by the mother, or was called to a location by the mother, the movement was classified as passive. The exploration period was 7 minutes long.

Measures. The measure of quantity of exploration was Number of Movements, computed by summing the number of times the child moved from one area to another. The measure of mode of exploration was Activity Ratio, computed by dividing the numer of active movements by the total number of movements (active plus passive). Also, three measures of pattern of exploration were computed: Percentage of Inside-Inside Movements (the number of movements made from one room to another within the playhouse divided by the total number of movements), Percentage of Outside-Outside Movements (the number of movements made from one area to another outside the playhouse divided by the total number of movements), and Percentage of Inside-Outside Movements (the number of movements made from inside to outside, or outside to inside, divided by the total number of movements).

Assessment of Cognitive Mapping Abilities

Procedure. After the exploration period, children were told, "Now we are going to play a hide-and-seek game with your mother. She is going to hide in the playhouse, and you and I will try to find her. Whenever you find her, she will give you a raisin."[1] Mothers had previously been told to "hide" in the room indicated in figure 1. The experimenter led the children to their mothers along the route indicated by the dashed line in figure 1. Leaving these doors open along the route, the experimenter then let the children lead the way to find their mothers, making sure that they did not depart from the designated route. After this was done four times, the experimenter closed the doors along the route, and again let the children lead the way, correcting them whenever they were about to make a wrong turn, and recording the errors made on each trial. Children were considered to have met criterion for training when they could anticipate the correct turns without guidance from the experimenter for two consecutive trials.

After reaching criterion, children were given two types of tasks to assess their spatial knowledge:

1) Detour tasks. The experimenter's assistant surreptitiously placed a barrier in front of the door marked D1 (for Detour 1) in figure 1. When the child arrived at this door, the experimenter said, "Oh, no! We can't go this way now. Go another way to find your mom. You can go any way you want." The experimenter's assistant then recorded the route taken by the child while surreptitiously following behind. Detour 1 was repeated, then the barrier was removed and the child walked along the regular route two more times. The above procedure was repeated with a barrier at the door marked D2, then at the door marked D3 (locations shown in figure 1). As before, the regular route was repeated twice after each detour task was repeated twice.

2) New route tasks. After completing the detour tasks, children were led outside the playhouse to the door marked NR1 (for New Route 1) in figure 1. The experimenter said, "Try to find your mom by going through this door instead of the way we usually go." The assistant then recorded the route taken by the child. New Route 1 was repeated. Children were then required to find their mothers from the door marked NR2, and finally from the door marked NR3 (locations shown in figure 1). New Routes 2 and 3 were each done twice also.

Measures. Two measures of cognitive mapping ability, Detour Score and New Route Score, were considered to be measures of the ability to integrate spatial information in order to infer the overall configuration of the environment. It seems likely that children must be able to mentally represent the layout of the experimental space fairly accurately if they are to perform well in these tasks. A third measure of cognitive mapping ability, Number of Training Trials, was considered to be a measure of the ability to learn and remember spatial information, in this case a sequence of turns. Good performance on this measure would not require integration of encoded information. Each detour task and new route task was scored from 0 to 5, based on the directness of the route chosen by the child.[2] Since each of the three different detour and new route tasks were repeated twice, both total Detour Score and total New Route Score could range from 0 to 30. Number of Training Trials was computed by summing the number of trials required to reach criterion, not counting the first four practice trials. For all measures except Number of Training Trials, higher scores indicated better performance.

RESULTS

Preliminary analyses of variance revealed no statistically significant main effects due to sex, nor any significant interations involving this factor. The data were therefore collapsed over sex in subsequent analyses.

Effect of Attachment Classification on Exploration

Each of the five measures of exploration were entered into a one-way analysis of variance. As shown in Table 1, the attachment groups differed in mode of exploration as measured by the Activity Ratio, $F(2,25) = 4.95$, $p<.05$. Children in the securely attached Group B had higher Activity Ratios than children in either of the anxiously attached groups, according to Duncan post hoc procedures. Attachment groups also differed in two of the three measures of pattern of exploration: Percentage of Inside-Inside Movements, $F(2,25) = 4.73$, $p<.05$; and Percentage of Inside-Outside Movements, $F(2,25) = 5.27$, $p<.05$. They did not differ in Percentage of Outside-Outside Movements, $F(2,25) = .40$, ns. Children in Group C, the anxious/resistant group, were more likely to confine their exploration within the playhouse, and less likely to go in and out of the playhouse during exploration, than were Groups A and B, according to Duncan post hoc procedures. Attachment groups did not differ in amount of exploration, as measured by Number of Movements, $F(2,25) = .38$, ns.

Thus, securely attached children were found to explore more independently than children in either of the anxiously attached groups, even though they did not differ in overall amount of exploration. Also, anxious/resistant children were more likely than anxious/avoidant and securely attached children to restrict their exploration to the interior of the playhouse.

Validity of Cognitive Mapping Scores

The two measures of ability to manipulate spatial information, Detour Score and New Route Score, and the measure of ability to learn a route, Number of Training Trials, were intercorrelated. Convergent validity for the construct measured by Detour Score and New Route Score was evidenced by a high correlation between these two measures, $r(26) = .64$, $p<.001$. Number of Training Trials was not correlated with Detour Score, $r(26) = -.06$, ns, but was correlated with New Route Score, $r(26) = -.47$, $p<.01$. This correlation most likely reflected the fact that children who required more trials to reach criterion were more likely to become tired toward the end of the experimental procedure, during the new route tasks.

Effect of Attachment Classification on Cognitive Mapping Abilities

Each of the three measures of cognitive mapping ability were entered into a one-way analysis of variance. As shown in Table 2, attachment groups differed in both of the measures of ability to manipulate spatial information: Detour Score, $F(2,25) = 7.17$, $p<.005$; and New Route Score $F(2,25) = 3.85$, $p = .058$. Duncan post hoc procedures indicated that securely attached Group B scored higher in detour tasks than both of the anxiously attached groups and higher in new route tasks than Group A. Group C was intermediate between Groups A and B in new route performance, and did not differ significantly from either group. Attachment groups did not differ on ability to learn a route, as measured by Number of Training Trials, $F(2,25) = .38$, ns.

Thus, securely attached children were better at integrating spatial information in order to make spatial inferences than were anxiously attached children, and anxious/avoidant children were somewhat worse than anxious/resistant children in this ability. Attachment groups did not differ in rote learning of spatial information.

Correlations Between Exploration, Cognitive Mapping Abilities, and Attachment Classification

Measures of exploration and cognitive mapping abilities were intercorrelated. Activity Ratio was found to be highly correlated with both measures of ability to integrate spatial information: Detour Score, $r(26) = .67$, $p<.001$, and New Route Score, $r(26) = .47$, $p<.01$. Activity Ratio was not correlated, however, with the measure of ability to learn a route, Number of Training Trials, $r(26) = -.11$, ns. Number of Movements was modestly correlated with Detour Score, $r(26) = .32$, $p<.05$. but not with New Route Score, $r(26) = -.05$, ns. Measures of pattern of exploration were not correlated with any of the measures of cognitive mapping ability (r's range from -.17 to .09). Thus, mode of exploration in the playhouse was related to the ability to integrate spatial information so as to create an accurate mental representation of the layout of the playhouse. Amount of exploration in the playhouse was less strongly related to this ability.

It is possible that the relationship between independent exploration and good cognitive mapping skills is an artifact in that each of these may be independently affected by security of attachment. That is, a general competence factor may underlie both independent exploration and successful congitive mapping in securely attached children. To determine if this is the case, partial correlation procedures were used.

The correlation between the Activity Ratio and cognitive mapping ability (the sum of the Detour and New Route Scores) was $r(26) = .67$, $p<.001$, if attachment was not held constant. The partial correlation with attachment (dichotomized into insecure versus secure) held constant was $r(26) = .47$, $p<.01$, suggesting that the relationship between mode of exploration and cognitive mapping abilities is not simply an artifact due to a general

competence factor. On the other hand, if a relationship exists between attachment classification and cognitive mapping abilities independent of mode of exploration, it can be argued that a general competence factor due to security of attachment does play some role in the development of cognitive mapping abilities. The correlation between attachment classification and cognitive mapping ability was $r(26) = .55$, $p<.001$, while the partial correlation with mode of exploration held constant was $r(26) = .35$, $p<.05$. Thus, cognitive mapping ability is independently related to both mode of exploration and security of attachment.

DISCUSSION

The findings of the present study replicate and extend those presented by Hazen (Note 3). Children's ability to infer configurational knowledge of a large-scale space was strongly associated with the extent to which their exploration was independent. Further, this relationship was found even when security of attachment was held constant, suggesting that it is not simply an artifact of general competent adaptation due to secure attachment. However, secure attachment does appear to foster general competence, since it is associated with high cognitive mapping abilities even when mode of exploration is held constant. It thus appears that all three factors interact to influence each other. Securely attached children have better cognitive mapping skills than insecurely attached children, and both their more independent exploration and thier effectance in dealing with problems contribute to this. Successful cognitive mapping may also make children feel more confident about exploring independently and dealing with problems in general, while poor cognitive mapping skills may further decrease independent exploration and feelings of effectance. Thus, a positive or negative spiral could result which maintains

the relationship between these three factors.

It is not necessarily the case, however, that the insecurely attached infant is doomed to become a passive explorer with poor cognitive mapping skills, or even to continue to lack general competence, during the toddler and preschool years. What is being proposed here is a transactional model rather than a unidirectional model (Sameroff & Chandler, 1975), such that individual differences in competent adaptation, mode of exploration and cognitive mapping skills exert mutual effects upon each other. Changes in any one of these can result in changes in how the child interprets and acts upon the environment, and such environmental changes can exert further effects upon mode of exploration, cognitive mapping skills, and feelings of effectance in the child.

The findings of this study also contribute to the rapidly growing body of data demonstrating that continuity in individual development can be found when developmentally appropriate issues are examined. The competent one-year-old has formed a secure attachment, enabling him or her to use the primary caregiver as a secure base for exploration. By age two, the competent child is striving for increased independence and autonomy, and seeks mastery over the environment. Thus, the children who had been classified as securely attached were more active explorers and higher in cognitive mapping abilities than those classified as anxiously attached. Continuity was found in general competence of adaptation rather than in the persistance of specific behaviors, since the anxious/avoidant group was higher in independent exploration than the securely attached group at age one, but not at age 2½. Presumably, the anxiously attached children lacked the confidence to explore as independently as the securely attached children due to unresolved conflicts stemming from the early attachment relationship.

The anxious/resistant group persisted in their pattern of limited

exploration between the ages of one and 2½. Their relatively low levels of active exploration and their tendency to restrict their exploration to the interior of the playhouse indicate a persistance of anxiety about exploration of the novel. One might expect, therefore, that this group would be lower than the anxious/avoidant group in cognitive mapping skills, since the avoidant group did have extra early experience in independent exploration, and appeared to be very object-oriented in the strange situation. Instead, the two anxiously attached groups did not differ, and in fact the Detour and New Route Scores of the avoidant group were somewhat lower than those of the resistant group.

It may be that the early independent exploration of the avoidant infants was a reflection of a desire to avoid interaction with the caregiver rather than an intrinsic interest in learning about the environment, and therefore these infants failed to encode the critical features and interrelationships of the objects they explored. The findings of a study by Connell (1974), which investigated the effect of attachment on habituation to a novel object, support this suggestion. Whereas securely attached infants were at first moderately wary of the novel object and then quickly habituated to it, avoidant infants were not wary of the object and did not habituate to it. Resistant infants were so wary that they often became very upset by the object, and so they did not habituate to it either. Thus, while the exploration of resistant children is limited by <u>too much</u> affective response to novelty, the ability of avoidant children to <u>learn</u> from exploration may be limited by <u>too little</u> affective response to novelty. If this pattern of affective response to novelty persists until the age of 2½, when securely attached children surpass avoidant children in their independence of exploration, it is easy to see why avoidant children would be found to have poor cognitive mapping skills.

In fact, it may be that resistant children can learn more from the limited environmental experience they obtain than can avoidant children, since resistant children presumably would need to be highly motivated to learn about a novel environment in order to overcome their anxiety about exploring it.

Finally, this investigation forges a link between an area generally classified within the domain of affective development, quality of attachment, and an area generally classified within the domain of cognitive development, cognitive mapping abilities. Although long neglected by cognitive psychologists, the effect of emotions on cognitive processing has recently become an issue of increasing importance (Flavell and Ross, 1981). In fact, Zajonc (1980) has asserted that cognitions are rarely, if ever, free of affective influences. Concerning spatial cognition, Ittleson (1973) has argued that "the first level of response to the environment is affective. The direct emotional impact of the situation...very generally governs the directions taken by subsequent relations with the environment" (p. 16). In spite of this, data concerning the role of affect on cognitive mapping abilities is just beginning to be accumulated. Acredolo (Note 1) has recently found that infants perform cognitive mapping tasks more accurately in their homes than in the laboratory because they feel more secure in their familiar home environment. Providing the infant with an extended "get acquainted" time in the laboratory eliminated these differences. Results of the present study suggest that individual differences in affective response to the environment may mediate styles of exploring and of encoding information about environments. Further research is required to test this hypothesis and to specify exactly how different types of affective reactions to the environment influence how children process information about the environment.

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Footnotes

[1]Other means were found to motivate children who did not want raisins, or tired of them during the experimental procedure. For example, several children delivered crayons or playdough balls to their mothers.

[2]Children received a score of 5 if they took the shortest possible route to the goal, 4 if they took the second shortest route, and so on. For example, the shortest route to the goal for Detour 1 would be the length of one playhouse room, the second shortest route would be the length of three rooms, etc; while the shortest route to the goal for New Route 1 would be the length of two rooms. If children took a route longer than the 5th shortest route, they were taken to the goal by the experimenter and received a score of 0 for that task.

TABLE 1

Means and Standard Deviations of Exploration Scores

Means and Standard Deviations of Exploration Scores as a Function of Attachment Group

Exploration Measure		Attachment Group		
		Group A	Group B	Group C
Activity Ratio	M	.73 $_b$	.88 $_a$	.65 $_b$
	SD	.15	.14	.24
% Inside-Inside Movements	M	.20 $_b$	.24 $_b$	.43 $_a$
	SD	.08	.15	.22
% Outside-Outside Movements	M	.28 $_a$	.31 $_a$	.24 $_a$
	SD	.11	.15	.27
% Inside-Outside Movements	M	.51 $_a$	.44 $_a$	.32 $_b$
	SD	.08	.17	.14
Number of Movements	M	31.19 $_a$	35.71 $_a$	31.71 $_a$
	SD	12.71	14.93	11.12

Note: Means not sharing the same subscript differ from one another according to Duncan's Multiple Range Procedure.

TABLE 2

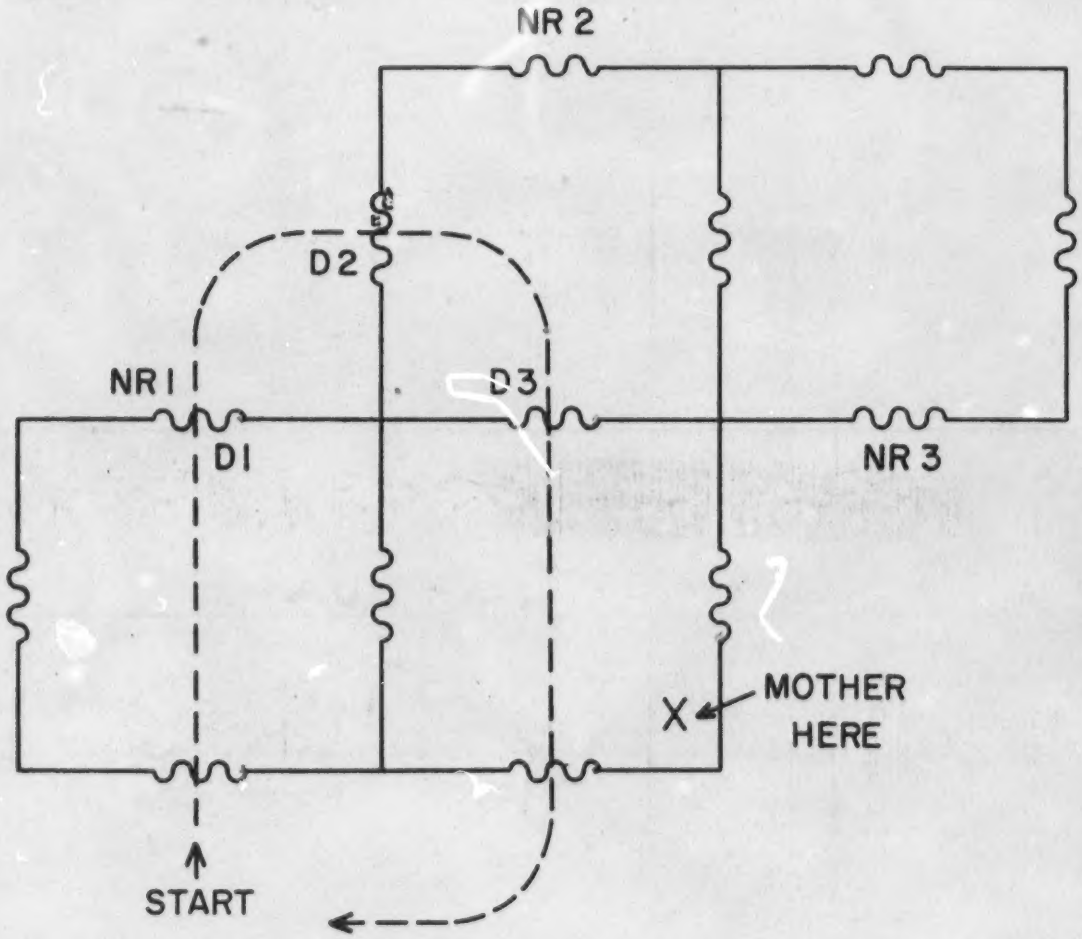
Means and Standard Deviations of Cognitive Mapping

Means and Standard Deviations of Cognitive Mapping Scores as a Function of Attachment Classification

Cognitive Mapping Measure		Attachment Group		
		Group A	Group B	Group C
Detour Score	M	20.50	25.54	21.86
	SD	3.30	2.63	3.85
New Route Score	M	17.63	22.31	19.29
	SD	4.34	4.50	3.73
Number of Training Trials	M	3.88	3.00	3.29
	SD	2.95	1.41	2.56

Figure Caption

Figure 1. Layout of laboratory "playhouse." Wavy lines indicate locations of curtain doors. Dashed line illustrates the route children learned to reach the room in which mother was "hiding." Locations of the three detour tasks are marked "D1," "D2," and "D3." Locations of the three new route tasks are marked "NR1," "NR2," and "NR3."


NR 2
D2
NR 1
D3
D1
NR 3
MOTHER
HERE
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START